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COURSES IN

CHEMISTRY

AND

CHEMICAL ENGINEERING

UNDER DIRECTION OF

WILLIAM B. SCHOBER, B.S., A.M., PH.D.

Application made for entry as second-class matter.

SOUTH BETHLEHEM, PENNA.

Published by the University.

LEHIGH UNIVERSITY

FOUNDED BY ASA PACKER

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WILLIAM B. SCHOBER, B.S., A.M., PH.D.

South Bethlehem, Pennsylvania

1907

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II. Requirements for Admission.

Candidates for admission to the Course in Chemistry or Chemical Engineering will be examined in the following subjects:

1. *English.*—This requirement includes: (*a*) English Grammar, especial attention being given to the analysis and correction of sentences; and (*b*) Rhetoric and Composition. Any High School Rhetoric will be sufficient, together with practical exercises in composition.

2. *American History*, with the elements of civil government. This includes colonial history, with a view to the origin and development of our institutions, and the period of discovery and early settlement, so as to set forth the relations of peoples in America and the meaning of the struggle for mastery. (As in Channing, McMaster, Thomas, or McLaughlin.) Throughout this examination special emphasis will be laid on knowledge of the physical and political geography of the countries concerned.

3 (*a*). *Elementary Algebra.*—Fundamental principles. Factoring. Least common multiple. Greatest common divisor. Fractions. Involution. Evolution. Radicals. Imaginary quantities.

Equations of the first and second degrees. Ratio. Proportion and progressions.

3 (*b*). *Advanced Algebra.*—Binomial Theorem for any exponent, Logarithms, Compound Interest and Annuities, Theory of Quadratic Equations, Variations, Indeterminate Equations, Inequalities, Undetermined Co-efficients and Partial Fractions.

4. *Geometry.*—Fundamental principles. Rectilinear figures. The circle. Proportional lines and similar figures. Comparison and measurement of the surfaces of rectilinear figures. Regular polygons. Measurement of the circle. Maxima and minima of plane figures, and plane and polyhedral angles. Solid geometry.

Candidates must have a knowledge of the metric system and be prepared to solve problems in either Algebra or Geometry involving the use of the metric units.

5. *Plane Trigonometry and Logarithms.*—Through the solution of right and oblique triangles. Candidates must bring their logarithmic tables to the examination.

ALL MATHEMATICAL SUBJECTS SHOULD BE THOROUGHLY REVIEWED IN THE LAST YEAR'S WORK OF THE PREPARATORY SCHOOL.

6. *Elementary Physics.*—This requirement may be met by a good course in any of the standard High School text-books in Physics, such as Gage's Elements of Physics, Carhart and Chute's Physics, or Avery's Elements of Natural Philosophy. Ability to solve simple numerical problems is required. In case the candidate has done laboratory work in Physics he should submit his laboratory note book at the time of his examination for entrance.

7. *German.*—This requirement will be satisfied by the completion of an amount equivalent to Part 1 of Joynes-Meissner's or Calvin Thomas's Grammar, Buchheim's Reader, and the reading of not less than 200 octavo pages of standard German texts.

An equivalent amount of French will be accepted in cases in which it is inconvenient for the candidate to offer German. The amount thus required in French is equivalent to Frazer and Squair's Grammar and the reading of not less than 200 octavo pages of modern French.

The candidate is expected to have acquired the ability to understand simple German (or French) prose. His proficiency will be tested by questions on the rudiments of Grammar, by translations of simple English sentences, and by translations at sight of easy German (or French) prose, containing no rare words.

Beginning September, 1908, French will not be accepted as an entrance subject for the courses in Chemistry and Chemical Engineering.

III. Program of Studies.

THE COURSE IN CHEMISTRY.

FRESHMAN YEAR.

FIRST TERM.		SECOND TERM.	
Analytic Geometry,	6	Calculus,	6
Chemistry,	2	Qualitative Analysis,	3
Chemical Laboratory,	2	Stoichiometry,	1
German *or* French,	3	Physics,	2
English,	3	Physical Laboratory,	1
Freehand Drawing,	1	German *or* French,	3
Gymnasium,	2	English,	2
		Gymnasium,	2

SOPHOMORE YEAR.

FIRST TERM.		SECOND TERM.	
Mechanics,	4	Physics,	3
Chemical Philosophy,	3	Physical Laboratory,	1
Quantitative Analysis,	5	Advanced Chemistry,	3
Quantitative Anal. Conference,	1	Blowpipe Analysis,	1
Physics,	3	Quantitative Analysis,	7
Physical Laboratory,	1	Quantitative Anal. Conference,	2
English,	2		

JUNIOR YEAR.

FIRST TERM.		SECOND TERM.	
*Quantitative Analysis,	6	Organic Chemistry,	4
Quantitative Anal. Conference,	2	Organic Chemistry Laboratory,	4
Physical Chemistry,	2	Metallurgy,	5
Physical Chemistry Laboratory,	1	Mineralogy,	3
Crystallography,	2	Economics,	1
Economics,	1		
Technical German,	2		

SENIOR YEAR.

FIRST TERM.		SECOND TERM.	
Metallurgy,	4	Industrial Chemistry,	3
Assaying,	3	Industrial Analysis,	3
Industrial Chem. Laboratory,	3	Industrial Anal. Conference,	1
Bacteriology,	2	Sanitary Chemistry Laboratory,	3
Blowpipe Analysis,	1	Geology,	2
Geology,	3	Electrometallurgy,	1
Theory of Electrolysis,	1	Electrometallurgy Laboratory,	1
Electrometallurgy Laboratory,	1	Thesis,	3

The terms are of equal length. The figures indicate exercises per week. A lecture or recitation period occupies one hour, a drawing period two hours, and a laboratory period three hours.

*Optional courses in Advanced Quantitative Analysis will be offered from year to year to students properly qualified. For 1907-1908 the courses embrace the analysis of ferro-alloys and the analysis of complex copper slimes.

THE COURSE IN CHEMICAL ENGINEERING.

FRESHMAN YEAR.

FIRST TERM.		SECOND TERM.	
Analytic Geometry,	6	Calculus,	6
Chemistry,	2	Physics,	2
Chemical Laboratory,	2	Physical Laboratory,	1
German, *or* French,	3	Qualitative Analysis,	3
Freehand Drawing,	1	Stoichiometry,	1
English,	3	German, *or* French,	3
Gymnasium,	2	English,	2
		Gymnasium,	2

SUMMER TERM.

Constructive Elements of Machinery and of Electrical Apparatus.

SOPHOMORE YEAR.

FIRST TERM.		SECOND TERM.	
Mechanics,	4	Advanced Chemistry,	3
Chemical Philosophy,	3	Quantitative Analysis,	4
Quantitative Analysis,	3	Steam Engine,	4
Quantitative Anal. Conference,	1	Machine Design,	3
Physics,	3	Physics,	3
Physical Laboratory,	1	Physical Laboratory,	1
English,	2		
Drawing and Mach. Design,	3		

SUMMER TERM.

Mechanical Technology.

JUNIOR YEAR.

FIRST TERM.		SECOND TERM.	
Quantitative Analysis,	4	Organic Chemistry,	4
Engineering Laboratory,	2	Organic Chem. Laboratory,	4
Elec. and Magnetism,	2	Metallurgy,	5
Electrical Laboratory,	1	Engineering Laboratory,	1
Dynamos and Motors,	2	Electrical Engineering,	2
Physical Chemistry,	2	Electrical Laboratory,	1
Physical Chemistry Laboratory,	1		
Technical German,	2		
Boilers,	1		

SUMMER TERM.

Engineering Laboratory.

SENIOR YEAR.

FIRST TERM.		SECOND TERM.	
Industrial Chem. Laboratory,	3	Industrial Chemistry,	3
Assaying,	3	Industrial Analysis,	3
Metallurgy,	4	Industrial Analysis Conference,	1
Bacteriology,	2	Sanitary Chemistry Laboratory,	3
Engineering Laboratory,	1	Electrometallurgy,	1
Mech. of Machinery,	2	Electrometallurgy Laboratory.	1
Economics,	1	Economics	1
Theory of Electrolysis,	1	Thesis,	3
Electrometallurgy Laboratory,	1		

IV. Synopsis of Studies.

THE COURSE IN CHEMISTRY.

ENGLISH.	
Rhetoric,	32
American Literature,	16
English Literature,	32
History of the English Language,	32
Essays,	12
	124

MATHEMATICS AND MECHANICS.	
Elementary Mechanics,	64
Analytic Geometry,	96
Differential and Integral Calculus,	96
	256

PHYSICS.	
Mechanics and Heat,	32
Electricity and Magnetism,	48
Light and Sound,	48
Physical Laboratory,	144
	272

MINERALOGY AND GEOLOGY.	
Crystallography,	32
Mineralogy,	48
Blowpipe Analysis,	80
Metallurgy,	144
Geology,	80
	384

CHEMISTRY.

General Chemistry Lectures,	32
General Chemistry Recitations,	32
General Chemistry Laboratory,	64
Qualitative Analysis,	144
Stoichiometry,	16
Chemical Philosophy,	48
Advanced Chemistry,	48
Quantitative Analysis,	864
Quant. Analysis Conference,	80
Organic Chemistry Lectures,	64
Organic Chem. Laboratory,	192
Assaying Lectures,	8
Assaying Recitations,	8
Assaying Laboratory,	128
Physical Chemistry,	32
Physical Chem. Laboratory,	48
Industrial Chemistry,	48
Industrial Chem. Laboratory,	144
Industrial Analysis,	144
Industrial Analysis Conference,	16
Sanitary Chemistry,	144
Electrolysis,	16
Electrometallurgy, .	16
Electrometallurgy Laboratory,	96
Thesis,	144
	2576
Gymnasium,	64
Freehand Drawing,	32
Economics,	32
German (*or* French),	96
Technical German,	32
Bacteriology,	96

The figures give the number of hours devoted to each subject.

THE COURSE IN CHEMICAL ENGINEERING.

ENGLISH.

Rhetoric,	32
American Literature,	16
English Literature,	32
History of English Literature,	32
Essays,	12
	124

MATHEMATICS AND MECHANICS.

Elementary Mechanics,	64
Analytic Geometry,	96
Differential and Integral Calculus,	96
	256

PHYSICS.

Mechanics and Heat,	32
Electricity and Magnetism	48
Light and Sound,	48
Physical Laboratory,	144
	272

ENGINEERING SUBJECTS.

Drawing and Machine Design,	192
Boilers,	16
Steam Engine,	64
Mechanics of Machinery,	64
Engineering Laboratory,	192
Electricity and Magnetism,	32
Dynamos and Motors,	32
Electrical Engineering,	32
Electrical Laboratory,	96
	720

CHEMISTRY.

General Chemistry Lectures,	32
General Chemistry Recitations,	32
General Chemistry Laboratory,	64
Qualitative Analysis,	144
Stoichiometry,	16
Chemical Philosophy,	48
Advanced Chemistry,	48
Quantitative Analysis,	528
Quantitative Anal. Conference,	48
Organic Chemistry Lectures,	64

Organic Chemistry Laboratory,	192
Assaying,	144
Physical Chemistry,	80
Industrial Chemistry,	352
Sanitary Chemistry,	144
Electrolysis,	16
Electrometallurgy,	16
Electrometallurgy Laboratory,	96
Thesis,	144
	2208

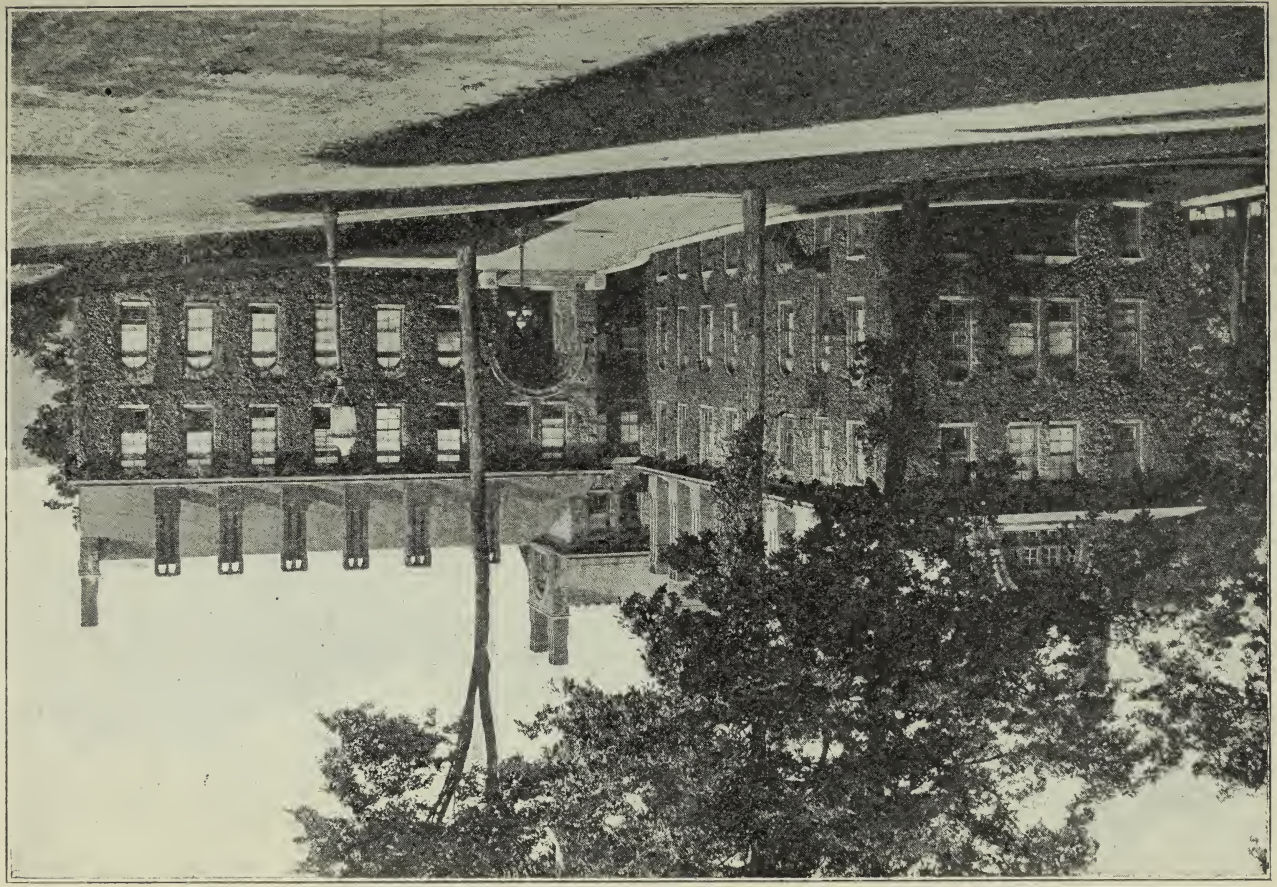
Freehand Drawing,	32
Gymnasium,	64
Economics,	32
German (*or* French),	96
Technical German,	32
Bacteriology,	96

V. The Chemical Laboratory.

This is a splendidly equipped, fire-proof building of sand stone, 219 feet in length by 44 in width, with a wing devoted to the courses in Metallurgy.

In the basement is the large laboratory for the furnace assay of ores, containing working tables for each student, twenty-nine crucible, two iron and eight muffle furnaces, with adjoining rooms for assay supplies, for balances, and gold and silver bullion analysis. On this floor there is also a toilet room, storeroom for acids, recitation room, a steam engine and air pump, which supplies the entire building with blast and suction, gas analysis laboratory, photometric laboratory, two laboratories for industrial chemistry, containing, in addition to the usual apparatus for the manufacture of chemicals, for calico-printing, dyeing and bleaching, an experimental plant for the manufacture of illuminating gas, an alcohol still, worm and doubler, and a working model of a steam centrifugal engine.

On the first floor is the large lecture room, seating 175 persons, the office and private laboratory of the professor of chemistry, two recitation rooms, lecture preparation room, museum, the office and private laboratory of the instructor in organic chemistry, and the laboratory for organic chemistry. This laboratory is supplied with air-baths, steam-baths, oxygen tank, combustion furnaces, etc. The working tables, like those throughout the building, have soapstone tops, and each table is provided with gas, water, suction, blast and high pressure steam. Adjoining this laboratory is a small balance room, and a coat room.



The laboratory for sanitary chemistry is also on this floor. It is provided with the necessary apparatus for the analysis of the substances given on page 21.

The second floor is devoted to laboratories for analytical chemistry, hydrogen sulphide room, offices and private laboratories of the instructors in qualitative and quantitative analysis, combustion room, balance room, supply room, and a small laboratory for industrial analysis.

The laboratory for Elementary Chemistry and Qualitative Analysis is a large, well-ventilated, well-lighted room, 22 feet in height, with desk-room for 84 students at one time, supplied with convenient working tables, vacuum filtration, hoods and steam-baths. Distilled water is delivered by faucet in this and the other laboratories.

The laboratory for Quantitative Analysis is another large room with desk space for 48 students, equipped like the Qualitative Laboratory, but is supplied in addition with the apparatus for the accurate and convenient carrying out of the operations of quantitative analytical chemistry.

One of the distinguishing features of this laboratory is the generous amount of desk-room, hood-space, steam-tables and other important accessories allotted to each student. The steam-tables in this laboratory are furnished with high pressure steam day and night, thus giving the student the opportunity of carrying on the tedious, time-consuming operations of evaporating solutions, drying precipitates and residues, etc., after the regular laboratory periods for the day are ended. This is a valuable advantage, which, in connection with the convenient arrangement of the equipment, is a most important factor in enabling the student to accomplish satisfactorily an unusually large amount of work in the time scheduled for it.

The material conditions are favorable for the development of a high degree of skill and rapidity in manipulation consistent with the requisite accuracy.

On this floor there is also a laboratory for the testing of alcoholic liquors, sugar, soap, oils, fats, explosives, paints, dyes and other industrial products.

On the third floor there is a store room, two dark rooms, recitation room, and room containing the still which supplies the building with distilled water.

The building is open daily from 8 a.m. to 6 p.m., and students are permitted to put in as much extra time as they desire.

VI. The Course in Chemistry.

The studies of this course are designed to prepare students for the profession of chemist, in connection with various manufacturing operations involving chemical or metallurgical principles; for the profession of expert or consulting chemist; for the preparation of teachers of chemistry, and as a course preliminary to the study of medicine.

With these objects in view, the instruction is of such a character as to emphasize the great importance of accurate work, to teach the student to make careful observations and deductions, to develop scientific habits of thought, as well as to give him a knowledge of the principles and facts of chemistry. The instruction is eminently practical, a large portion of it being devoted to laboratory work during the four years necessary to complete the course.

Graduates of this course receive the degree of Bachelor of Science in Chemistry.

GENERAL AND SCIENTIFIC STUDIES.

The subjects included in the course in Chemistry other than those of a chemical character, are: English, German (or French), Physical Culture, Analytic Geometry, Differential and Integral Calculus, Mechanics, Physics, Freehand Drawing, Crystallography, Blowpipe Analysis, Mineralogy, Geology, Electrolysis, Metallurgy, Electrometallurgy, Economics, and Bacteriology.

The time devoted to these subjects has been given in the Program and Synopsis of Studies. Fuller details concerning them may be found in the University Register.

GENERAL CHEMISTRY.

During the first term of the Freshman year the introduction to the fundamental principles of chemistry is presented to the student by lectures, fully illustrated by experiments, charts and specimens from the Museum, recitations and laboratory work. Each student repeats at his laboratory desk many of the experiments he has seen performed on the lecture table. He is thus able to verify the statements made in the lectures and text, to develop his powers of accurate observation and of drawing correct inferences from such observations. He records his observations and deductions immediately after performing an experiment, in a laboratory note book which is examined and corrected daily by an instructor in the presence of the student. He has the opportunity at all times of consulting the instructor about difficulties that may arise, but he is urged not to ask any questions which he may be able to answer for himself by a little thought, or reference to a suitable text.

The laboratory sections are small. Usually each instructor has charge of not more than fourteen students. With the small laboratory sections, the three phase method of presentation of the subject,—lectures, recitations and individual experimentation—in addition to the daily personal attention which every student receives, he has unusual facilities for acquiring a thorough knowledge of the subject.

The text book is Remsen's Chemistry, Briefer Course.

QUALITATIVE ANALYSIS.

The study of Qualitative Analysis is taken up at the beginning of the second term and continued throughout the term. This course is open to all students who have passed the examinations in the General Chemistry of the first term.

Lectures on the subject are delivered to the class, during which the reactions involved in the detection and separation of the elements and compounds are explained and demonstrated by experiments.

The laboratory work consists in individual experimentation covering the necessary tests and the methods for making separations of elements and compounds.

The student is encouraged by suggestions and references to the text to supplement the knowledge gained from the experiments, and to learn to express correctly the particulars of any chemical action he has brought about. He records his observations in a note book, which is inspected at each laboratory exercise by the instructor, who discusses with the student the work performed and recorded.

During the term each student analyzes about forty "unknown" substances. Whenever it seems desirable, the instructor performs an analysis with the student, during which the details of manipulation and the method of procedure are pointed out. The text-book is Treadwell's Analytical Chemistry, Vol. I.

STOICHIOMETRY.

This is a class-room subject of two hours per week, running parallel with Qualitative Analysis.

A portion of the time is devoted to instruction in the theory and practice of qualitative analysis, to the writing of equations expressing the reactions carried out in the laboratory, and to the discussion of the usual difficulties which the student encounters.

The remainder of the time allotted to the subject is devoted to the solving of problems involving the calculations that arise in analytical, synthetical, metallurgical and other industrial processes.

The texts used are Treadwell's Analytical Chemistry, Vol. I, and Whiteley's Chemical Calculations.

CHEMICAL PHILOSOPHY.

This is a course in theoretical chemistry given during the first term of the Sophomore year. The fundamental theories and laws of chemistry are discussed and their value in the interpretation of chemical facts emphasized. The text-book is Tilden's Chemical Philosophy.

ADVANCED CHEMISTRY.

Instruction in this subject is given in the second term of the Sophomore year. It includes a systematic study of the elements and their compounds. The course is based upon Newth's Inorganic Chemistry.

QUANTITATIVE ANALYSIS.

Mineral, Gas, Sanitary, Industrial Organic Analysis

The subject of quantitative analysis claims the attendance of the student of chemistry for nineteen hours per week during a period equivalent to two collegiate years—two terms during the Sophomore year, one term during the Junior year, and again in the final term of the Senior year.

Usually the graduated student's first occupation is most intimately connected with the knowledge of and practical ability in analytical methods, and it is essential that his instruction and opportunities for development should be laid along lines of broad scientific foundations and adapted to the methods of modern practice.

Supplementing the individual instruction given in the laboratory, there is carried on a series of lectures, recitations, and more informal class-room exercises, in which are discussed the methods and processes of analysis employed, the relation of quantitative analysis to other branches of chemistry, the laws of solution, precipitation, mass-action, etc., etc., which bear upon the subject in hand and lead to the mastery of a profession rather than expertness in a trade.

A careful determination of the constants of a balance as applied to quantitative analysis precedes actual analysis. Rigorous gravimetric determinations of moisture, sulphur trioxide, iron, barium, magnesium, and chlorine introduce the beginner to the subject. These are followed by the preparation and use of standard solutions required in the volumetric methods included under acidimetry, alkalimetry and chlorimetry. More complicated analyses are now taken up. A complete analysis of limestone and cement, iron ore, copper ore by electrolytic method, spiegel iron, coal, zinc ore and its metallurgical products, lead ore, copper alloys, and ores containing titanium. The course thus far outlined is completed in the Sophomore year.

During the first term of the Junior year analyses are made of pig iron, steel, pyrolusite, clay, nickel ores, refined copper, copper ores, fuel gas and illuminating gas.

For students properly prepared, further optional courses are offered: for 1907-'08, these will include ferro-alloys and complex copper slimes.

After the student has completed the course in organic chemistry in his Junior year and the course in industrial chemistry in the first term of the Senior year, quantitative analysis is again taken up as industrial and sanitary analysis, and includes drinking water, air, milk, butter, lard, fermented liquors, illuminating and lubricating oils, soaps, fats, fertilizers, explosives, tan-liquors, syrup and sugar. In the whole course of quantitative analysis the samples for analysis are those met with in industrial practice, and the course is arranged to cover as many branches of industrial activity as is consistent with thorough work and the time allotted to the subject. The methods of analysis are taken from text-books, scientific journals and government publications, supplemented by the most accurate and time-saving methods that obtain in the practice of modern industrial and works laboratories.

PHYSICAL CHEMISTRY.

In addition to his training in physics and chemistry, each student receives special training in physical chemistry. The course is mainly one of recitations from Jones's Physical Chemistry, with informal lectures and explanations by the instructor. Two hours per week are devoted to this subject in the classroom, and three hours in the laboratory, during the first term of the Junior year. The laboratory work consists in the determination of molecular weights, and physico-chemical measurements.

ORGANIC CHEMISTRY.

Instruction in this subject is given during the second term of the Junior year. Four lectures and four laboratory periods per week are devoted to it. The lectures, fully illustrated by experiments, specimens from the museum, charts, etc., deal with the representatives of important classes of carbon compounds. A special effort is made to give the student a thorough knowledge of the fundamental principles of organic chemistry.

The laboratory work, requiring twelve hours per week, consists in the determination of physical constants of organic compounds, the quantitative analysis of organic compounds and a graded course of synthetic operations,—from thirty to thirty-five compounds are prepared by each student. The course in preparations begins with the simpler compounds, methane, ethane, ethyl bromide, iodoform, ether, etc., etc. As the student acquires skill in manipulation, more difficult preparations are given him, but each experiment assigned is of such a character as to involve the knowledge of, or introduction to some fundamental principle. While working with a compound the student is encouraged to read the literature concerning it.

Supplementing the lectures and laboratory exercises, the instructor gives each student personal instruction daily at his working table.

A course of historical lectures is given by the students during this term. This course is intended to familiarize the student with certain selected fields of the literature of organic chemistry, and to give him an opportunity to acquire a clear, concise style in the discussion of scientific subjects.

INDUSTRIAL CHEMISTRY.

This important branch of chemistry receives the student's attention for three periods per week throughout the Senior year; a portion of the instruction is devoted to lectures and recitations, but the greater part is given to laboratory work. The main object of this course is to familiarize the student with the methods and processes employed in representative industrial plants. A part of the laboratory work consists in the manufacture of chemically pure compounds from raw materials, dyeing and calico-printing, experiments in fermentation and rectifying, the manufacture of illuminating gas and various other selected experiments illustrating certain phases of industrial activity. The chemicals are prepared in as large quantities as can be conveniently handled in the laboratory.

The instruction in dyeing and calico-printing consists of recitations based on Frap's Principles of Dyeing, lectures and practical exercises. The latter includes the application of a

number of typical dyes to the various fibers in the form of cloth and yarn.

The shop visits (see page 21) are a most valuable part of this course.

ASSAYING.

Nine hours per week, (lectures, recitations and laboratory work,) are devoted to this subject during the first term of the Senior year.

In 1906-1907 each student made the following assays:

Lead Sulphide Ores (*a*) Black Flux—Substitute Method. (*b*) Iron Nail Method.

Antimony Sulphide Ores, Cyanide Method.

Tin Oxide Ores, Cyanide Method.

Rich Lead.

Gold Bullion, Silver Bullion. Official U. S. Methods.

Copper Matte, Dry Method, with a discussion of the Wet and Combination Methods.

Gold and Silver Ores, six ores by Crucible and three by Scorification Methods.

Text-Book: Lodge's Notes on Assaying.

SANITARY CHEMISTRY.

There is a laboratory course of nine hours per week during the second term of the Senior year. It consists in the qualitative and quantitative examination of air, water, food, disinfectants, baking-powders, flour, bread, tea, coffee, cocoa, spices, milk, butter, lard, beer and other substances naturally included in this branch of the science.

VII. Shop Visits.

The proximity of the University to the various important industrial and metallurgical plants of the Lehigh Valley, New York City and Philadelphia, offers to the student of Chemistry or Chemical Engineering at Lehigh unusual facilities for acquiring a valuable knowledge of industrial processes. A part of the regular instruction in industrial chemistry consists in visits of inspection made by the students, accompanied by an in-

structor, to manufacturing plants. Through the courtesy of the superintendents, our students had the privilege of visiting, during the year 1906-1907, the establishments named below:

The Bethlehem Steel Company, South Bethlehem, Pa.,
The New Jersey Zinc Company, South Bethlehem, Pa.
The W. F. Romig Distillery, Stockertown, Pa.
Northampton Cement Co., Stockertown, Pa.
Lotte Bros. Dye Works, Allentown, Pa.
Horlacher's Brewery, Allentown, Pa.
Atlas Cement Co., Alliance, Pa.
United States Mint, Philadelphia, Pa.
Tacony Chemical Co., Bridesburg, Philadelphia, Pa.
Welsbach Light Co., Gloucester City, N. J.
Harrison Bros. and Co. Inc., Philadelphia, Pa.
Gleason Teibot Glass Works, Brooklyn, N. Y.
George Stratford Oakum Co., Jersey City, N. J.
New Jersey Tissue Paper Mill, Jersey City, N. J.
Gautier Crucible Works, Jersey City, N. J.
Babbitt Soap Works, New York City.
Consolidated Gas Co., New York City.
Board of Health Laboratory, New York City.
American Sugar Refining Co., New York City.

VIII. Theses.

The subjects for the graduating theses of the candidates for the degree of Bachelor of Science in Chemistry or Chemical Engineer, are chosen in the first term of the Senior year, subject to the approval of the professor of chemistry. The thesis is regarded as a part of the final examinations of the courses, and involves laboratory work, a careful examination of the literature relating to the subject, and informal conferences from time to time. The originals will be kept by the University, as a part of the student's record; but a copy may be retained by the student and be published, permission being first obtained from the Faculty. The following are the titles of theses presented by the graduates in the years 1899-1907.

Coffee and Its Adulterations. R. C. Becerra, Jr.

Commercial Sugars, their Properties and Production, with Experiments on the Cultivation of Sugar Beets in the Saucon Valley, Northampton County, Pa. William Gummere.

Portland Cement. Geo. A. Horne.

Preparation of Isomeric Amyl Acetates, used as Flavoring Extracts. Geo. K. McGunnegle.

Meta-amido-benzene Sulphonic Acid and its Derivatives. W. L. Meaker.

The Dispositon of Tannic Acid in Tanning. W. F. Ulrich.

The Acetine Derivatives of Glycerine. F. C. Wettlaufer.

The Action of Sulphuric Acid on Amyl-phenyl Ether. John E. Leibfried.

The Volumetric Determinaton of Zinc. Kenneth W. McComas.

Catalytic Formation of Sulphuric Acid. E. T. Satchell.

The Action of Sulphuric Acid on Isopropyl-phenyl Ether. N. W. Buch.

Molybdenum and its Compounds: Preparation and Properties. F. B. Gearhart.

Cultivation and Manufacture of Sugar in Cuba. A. J. Sanchez.

The Action of Sulphuric Acid on Isobutyl-phenyl Ether. E. B. Wilkinson.

Arachis or Peanut Oil: Its Manufacture, Detection, Adulteration and Uses. A. G. Bachman.

Underburnt and Overburnt Cement. A. A. Diefenderfer.

Use and Detection of Formaldehyde in the Preservation of Food. C. A. Gradwohl.

Diacetin. W. L. Heim.

Determination of Chromium in Iron and Steel. J. McVey,

The Electric Preparation of Chemical Salts. G. C. Beck.

Isopropyl-phenyl Sulphonic Acid and its Derivatives. Courtland F. Carrier, Jr.

Examination of Lehigh River Water. A. E. Olpp

Manufacture of Potassium Chlorate by the Electrical Process. H. P. Barnard.

The Weighting of Silks. W. L. Bruner.

The Quantitative Determination of Zinc. W. W. Fitch.

The Properties of Radium and its Separation from Pitchblende. L. R. Garrison.

The Action of Nitric Acid on Ferrous Sulphate. P. T. Krause.

The Manufacture of Paper from Wood. H. W. Pfahler.

The Preparation and Properties of Silver Carbide. W. H. Welker.

A Chemical and Bacteriological Survey of the Water Supply of South Bethlehem. Arthur Edgar.

The Investigation and Preparation of Photographic Fabrics. C. H. Ohlwiler.

A New Method for the Determination of Phosphorus in Phosphor Bronze. C. B. White.

Methods for the Determination of Free and Albumenoid Ammonia in Drinking Water. Clyde Denlinger.

Investigation of Aromatic Ethers. S. H. Salisbury, Jr.

Investigation of the Effect of Moisture on the Production of Pig Iron and the Consumption of Coke. W. C. Smith.

Sanitary Survey of the Milk Supply of South Bethlehem, 1905-1906. J. G. Smull.

Sanitary Survey of the Milk Supply of South Bethlehem, 1906-1907. R. L. Lafferrander.

The Action of Sulphuric Acid on Pig Iron. M. H. Ulman.

IX. Graduate Courses.

The degree of Master of Science is conferred upon any candidate, otherwise properly qualified, who after having taken the degree of Bachelor of Science, or its equivalent at any college or University, shall pursue for at least one year at this University, a course of advanced study in two departments (under two professors), pass the examinations of the same and present a satisfactory thesis.

The course of study may be selected, with the approval of the Faculty, from the list of subjects given in the Register, at least fifteen exercises per week being chosen in two departments. About two-thirds of the work is to be in one department and

about one-third in another, these being called the major and minor departments. The thesis is to be prepared on a subject connected with the studies of the major department.

Candidates who desire to receive the Master's degree in June of 1908 are required to confer with the professors on or before September 21,1907, and to present their courses of study to the Faculty for approval on September 23, 1907.

Graduate courses are offered in the Department of Chemistry and Chemical Engineering as follows:

1. Industrial Chemistry.
2. Sanitary Chemistry.
3. Organic Chemistry.
4. Inorganic Chemistry.
5. Analytical Chemistry.

IX. Special Courses.

Special courses, not leading to a degree, are offered to all who shall present to the Faculty satisfactory evidence of such previous training as will enable the candidate to meet the requirements of the courses he may wish to pursue. Such courses may be made up from the program on pages 8 and 9. In no case will a first term subject be given in the second term, or a second term subject in the first term.

X. Summer Schools.

There are no required summer schools in the course in Chemistry, but for those students of this institution or others, having conditions or wishing to pass off subjects in advance, courses in elementary chemistry, qualitative analysis, quantitative analysis, stoichiometry and assaying will be given. With the exception of elementary chemistry, these courses are identical with the regular courses offered during the year.

The instruction begins July 31, 1907, and continues for four weeks.

In the course in Chemical Engineering, attendance is required in the summer schools, lasting four weeks, at the end

of the Freshman, Sophomore and Junior years. See program of studies, page 9.

XI. The Course in Chemical Engineering.

A demand exists for young men who have acquired a knowledge of chemistry and of mechanical engineering. The course in Chemical Engineering is intended to prepare students to meet this demand.

In this course the training is essentially chemical and the graduates are primarily chemists with a good knowledge of mechanical and electrical engineering.

This equipment is considered more valuable for the chemical engineer than a fundamental training in engineering and a somewhat limited knowledge of chemistry, since the problems of the manufacturing chemist are not essentially mechanical ones. Although six years' work covering most of the studies of both the chemical and mechanical courses would be found advantageous for the chemical engineer, this shorter course, of four years, will meet most of his requirements.

Graduates of this course receive the degree of Chemical Engineer (Ch.E.).

The course in Chemical Engineering differs from the course in Chemistry in that it does not include Crystallography, Blowpipe Analysis, Mineralogy and Geology; the time devoted to Quantitative Analysis is shortened from 944 hours to 576. The additional subjects given are as follows:

DRAWING AND ELEMENTS OF MACHINE DESIGN.

Tracings and blue prints. Sketches and working drawings of machine pieces. Interpretation of machine drawing by isometric sketches. General view from given details. Sections of stub ends and valve passages. Intersection of boiler flues. Empirical proportioning of machine parts.

Proportioning of such machine parts as come under the head of fastenings, bearings, rotating and sliding pieces, belt and toothed gearing, levers, and connecting rods.

BOILERS.

Description of various types, and of details of construction, staying, setting etc.; strength of the structure; accessories, fuels and furnaces; operation; wear and tear; visits of inspection to a boiler shop and to a boiler plant. Text-book: Peabody and Miller.

STEAM ENGINE.

Elementary Thermodynamics, theory of the ideal heat engine, properties of steam and efficiency of the steam engine. Mechanics of the engine, steam pressures, inertia resistances, turning force diagrams, etc. Valve gears, valve diagrams applied to slide valves, shaft governors, and link motion. The steam engine indicator and study of diagrams. Outline of the study of economy, compounding, etc. The descriptive work is supplemented by shop visits. The solution of many graphical and numerical problems is required. Text-book: Heck's Steam Engine.

ENGINEERING LABORATORY.

Use and calibration of apparatus for measuring weight, volume, pressure, temperature, speed, etc., for engineering purposes.

Indicator practice, on engines in the laboratory and in factories and power plants in the neighborhood; complete working up of indicator diagrams from simple and compound engines, air compressors, etc. Tests of boilers, of power plants and of pumping stations in the neighborhood. Advanced work along the lines of the course in Engineering Laboratory given below.

ELECTRICITY AND MAGNETISM.

Electrical units, electrical measurements, inductance, the magnetism of iron, and electromagnetic theory. Lectures, recitations, and problem work.

ELECTRICAL LABORATORY.

Laboratory work accompanying the above course. Precise electrical measurements.

DYNAMOS AND MOTORS.

This is an abbreviated course adapted to those students who do not continue this subject in the following year. Special attention is given to the operation, regulation, management, and methods of testing of dynamos and motors. Illustrative problems.

ELECTRICAL ENGINEERING.

Continuation of the course in Dynamos and Motors. Special attention is given to outside and interior wiring; overhead and underground line construction. The latter part of this study is devoted to the standard types of alternating current machines, including alternators, motors, rotary converters and transformers.

MECHANICS OF MACHINERY.

Graphical statics of mechanisms. Determination of the efficiency of a machine and of the forces acting in every one of its pieces and parts. All the problems are given to the students in the form of black prints and consist of a series of suitably graded examples of machinery. In these both frictional and inertia resistances are considered.

CONSTRUCTIVE ELEMENTS OF MACHINERY.

Visits of inspection. Examination and sketching of machine parts and machinery. A classified and numbered list of some three hundred and sixty items is given to each student, who makes a written report on them with freehand sketches containing the leading dimensions. The class is divided into sections, which are separately taken into the shops by the instructor, who then indicates the pieces that are to be examined and gives all necessary explanations. In addition a score of machines of all sorts are taken apart and again put together by this class. This work is accompanied by Constructive Elements of Electrical Apparatus. Summer term, four weeks, beginning June 11, 1908.

CONSTRUCTIVE ELEMENTS OF ELECTRICAL APPARATUS.

Studies of electrical machinery and appliances with the object of familiarizing the student with principles of operation, structural details, and practical uses. The student is supplied with a complete printed outline of the work to be done containing full instructions and explanations. The work consists of three parts, as follows: (*a*) Illustrated lectures, (*b*) Inspection and sketching of electrical machines and apparatus, and (*c*) Visits of inspection to neighboring electric light and power plants. Written reports are required on each day's work. This work is accompanied by Constructive Elements of Machinery. Summer term, four weeks, beginning June 11, 1908.

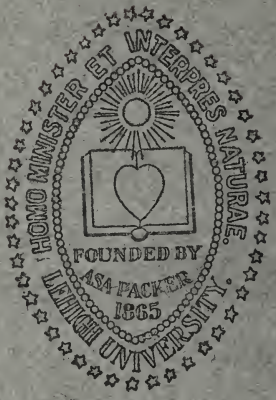
MECHANICAL TECHNOLOGY.

Each student is required to give a full written description of the various processes, operations and tools involved in the production of each one of a series of properly graded examples of patterns, castings, forgings, and finished pieces, which are under construction in the shops at the time and drawings for which have been given to him on entering the shops. The student's work is personally directed by an instructor, who accompanies him in each shop, gives necessary explanations, and tests the extent and accuracy of his knowledge. Four teachers are engaged for this work, one for each shop and section. Summer term, four weeks, beginning June 11, 1908.

ENGINEERING LABORATORY (SUMMER SCHOOL).

Simple tests with steam: steam calorimeters, injectors, flow of steam, performance of steam-traps, etc.; tests of small steam pumps, of a steam turbine, of engine performance; of hot-air and gas engines, and of an air compressor. Boiler management and testing. Dynamometer work, belt testing, friction and lubrication. Summer term, four weeks, beginning June 11, 1908.

For further information, intending students should consult the University Register, obtainable, on request, from the Registrar.


HOMO MINISTER ET INTERPRES NATURAE
FOUNDED BY
ASA PACKER
1865
LEHIGH UNIVERSITY